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Sources of Economically Valuable Features for Selection of Vigna (Cowpea) in Conditions of Absheron Peninsula

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ABSTRACT

Background: In recent years, large areas are periodically exposed to drought due to the climate change towards warming. In this regard, there is a need to expand the area of cultivation of drought-resistant leguminous crops. One of these species of interest for cultivation in the central lowlands of the Republic of Azerbaijan, where bean crops are greatly suppressed, is vigna. To date, this culture is not widespread, its biological and energy potential is underestimated. Therefore, the study of morphological and biological characteristics of promising varieties of cowpea in the region and a comprehensive study of the genetic resources of the culture is relevant. The purpose of the research is to study the cowpea collection, to identify forms with economically valuable traits and to create on their basis a new highly productive, technologically advanced, valuable with its quality vigna grain for a selection in the conditions of the Republic of Azerbaijan.

Methods: The studies were conducted in 2007-2018 at the Institute of Genetic Resources (IGR) of the National Academy of Sciences (NAS) of Azerbaijan. 33 samples were used as research material: 9 of them were local forms and 24 were samples obtained from VIR. The vegetation period and resistance to diseases have been studied and the productivity and structure of the harvest have been analyzed.

Result: As a result of research, the most high-yielding and high-quality samples K-269, K-257, AzeVİG-2, K-271, K-262, AG-340 were revealed in the studied vigna samples. During the implementation of the breeding program using the results, we have developed a new early ripe, drought-resistant, heat-resistant, disease-resistant and high-yielding variety Ayla by the method of repeated individual selection from the VIR collection. These studies are an important initial study for the subsequent production of new varieties. We hope that this will lead to an increase in the acreage of cowpea in the Republic of Azerbaijan.

Key words: Alternative feeding source, Initial material, Legumes, Plant breeding, Protein, Vigna (cowpeas).

INTRODUCTION

To the genus vigna savi belong 57 (Jhukovski, 1971; Verdcourt, 1970) to 200 species (Fery, 2002). Some researchers believed that the birthplace of the cultural species of vignais in Arabia and Central Asia. According to Wight (1907), cowpeas originate from the Caspian steppes. Ivanov (1937), on the basis of a differential agronomic study of the world collection of vignaVIR, in 800 samples, considers the mountainous region of large lakes Eastern Africa, Kenya, Uganda and South as the birthplace of the vigna culture and South Abyssinia, as area of the emergence of cultural forms of *Vigna sinensis* and *Vigna catjang*.

Academician Vavilov (1935) quotes three sources of the origin of cultural cowpea: the Chinese source is secondary for *var.sesquipedalis*, the Indian source is for *Vigna sinensis Endli*. and the Abyssinian source for *Vigna sinensis Endli.* (Vavilov, 1965).

Vigna unguiculata (2n = 2x = 22) is believed to have originated in Africa where a large genetic diversity of wild types occur throughout the continent, particularly southern Africa, however the greatest genetic diversity of cultivated cowpea is found in west Africa (PROTA, 2006). Pasquet, (1999) reported cowpea domesticated in Northeast Africa and a secondary center of domestication was in West Africa and the Indian sub-continent. In present, cowpea is an essential crop in developing countries of the tropics and subtropics, especially in sub-Saharan Africa, Asia, Central and South America (Singh *et al.* 1997).

V. unguiculata has 11 subspecies including 10 wild perennial subspecies and one annual subspecies (ssp. *unguiculata*) (Maxted *et al*., 2004; Pasquet, 1996b); Subspecies *unguiculata* comprising of a culti-vated form (var. *unguiculata*) and a wild form (var. *spontanea*). The cultivated forms (var. *unguiculata*) of ssp. *Unguiculata* are further distinguished to five following cultivar groups (cv-gr) based mainly on pod and seed characteristics (Fang *et al*., 2007; Pasquet, 1996a).

– cultivar-group (cv-gr.) *Unguiculata*: cowpea, black-eye bean; The most widespread and economi-cally important group of the species; They are pulse and vegetable types.

– cultivar-group. *Melanophthalmus:* The most recently

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recognized cultivar-group, it is based on the taxon with a thin testa and often wrinkled and is cultivated mainly in West Africa.

– cultivar-group *Biflora*: (catjang cowpea). Mainly cultivated in South Asia (India, Sri Lanka). It is grown as a pulse or as forage crop, especially for hay and silage and as a green manure crop; Much less variable than the true cowpea.

– cultivar-group *Sesquipedalis*: Yardlong bean, asparagus bean. It is climbing grown as vegetable, immature pods and seeds are used as a green vegetable.

– cultivar-group *Textilis:* plants cultivated for the fibers extracted from their long peduncles (Pasquet, 1998).

The selection of cowpea as a pulse as well as for fodder might have resulted in the establishment of the culti-group Unguiculata (Ng and Sign, 1997). Cowpea was first introduced to India 1000-1500 years ago. India appears to be a secondary center of diversity of cowpea, since significant genetic variability occurs on the subcontinent.

Of the 22 types of leguminous crops cultivated in the Republic of Azerbaijan, 4 types of vegetables are used on the food purposes: sewed bean (*Pisum sativum L.*), common beans (*Phaseolus vulgaris* L.), horse beans (*Vicia faba* L.) and vigna [*Vigna unguiculata* (L.) Walp] (Asadova *et al*., 2016).

A rare form of cowpea is found in Azerbaijan – *proles azerbaidjanica*. The bush is erect, spreading, tall, height 70-80 cm. The lateral branches are long, from 60 to 100 cm, pointing upwards, their number from 6 to 10 pieces. Leaflets are rhomboid, of average size (8-10 cm). Colour is green and leaves are medium. Beans are short and the length varies from 11 to 17 cm. The colour of mature beans is yellow and the colour of not mature bean - with anthocyanin. The walls of the beans are thin and the beans are cracking. Beans are located on medium-length peduncles (25-30 cm), the number of beans on the peduncle is 1-3 pieces. The number of seeds in a bean is 10-15 pieces. Seeds are small, 0.6-0.8 cm long. Coloration of seeds is yellowish-pink, cylindrical. The length of the growing season is 90-110 days (Pavlova, 1937).

The purpose of this work is the study of the gene pool from the collection of VIR and the national gene pool of *vigna*, which can serve as a source material for domestic selection.

MATERIALS AND METHODS

The studies were conducted in 2007-2018 at the Institute of Genetic Resources (IGR) of the National Academy of Sciences (NAS) of Azerbaijan. The IGR is located on the Absheron peninsula (80 m above sea level), in a dry subtropical climate with very sunny and dry summers, warm and sunny falls and mild almost snowless winters. The average temperature is 13.5-14.5°C. Frost in winter is rare. In summer, the temperature climbs up to 38-40°C and since 2010 this can reach to 40-45°C. The driest months are July and August. Most of the rainfalls occur in winter-spring period. Average yearly rainfall is mediocre and constitutes 120-150 mm and relative humidity is 70.6%. Summer is almost always dry. The soil is sandy and very poor. Caspian Sea and semi-arid plains surrounding the peninsula has big impact to the climate.

The following methods were used during the research: state method of testing plant varieties (1989), methodology for the definition of a key set of characterization and evaluation descriptors for cowpea (*Vigna savi*) (2011).

If for mathematical calculations we made use of the field experiment methodology (with the basics of statistical processing of research results) of V.A. Dospekhov (Dospekhov, 1985), Microsoft Excel software was used to obtain experimental data for statistical work and the results of statistical evaluation, analysis of field and laboratory experiments were used for SPSS software package.

Sowing of collection samples was carried out in duplicate with an area of food of one plant 10 × 60cm at the optimum time, in the spring at the end of April. A standard sample was sown after every 10 samples, with the method of systematic placement of experimental plots. In the process of growing, the ranks made phenological observations, determined the time of onset of phenological phases. The onset of the phase was noted when there were signs in 10% per cent of the plants and complete in the presence of signs in 75% per cent of the plants. The dates of the onset of the main phases and interphase periods were noted: seedlings, flowering, fruiting and ripening of beans. In connection with the above, in Azerbaijan, studies were conducted on the study of agro-biological features of beans in the conditions of the Absheron Peninsula.

33 samples were used as research material: 9 of them were local forms and 24 were samples obtained from VIR. Variation in seed of some samples has been shown in Fig 1.

RESULTS AND DISCUSSION

The goal of the research was to study the variability of the morphometric and biochemical characteristics of introduced sample varieties of vigna and to create of a source material for the new varieties selection.

Growing period largely determines the suitability of a variety for cultivation in a particular area. Many economic and biological characteristics and properties of the species are connected with the duration of the growing season (resistance to drought, diseases and pests, quality of the product and, ultimately, crop yield.

According to our observations, depending on meteorological conditions, the duration of the sowing-harvest period has a high volatility (9-29 days). The duration of this period depends on the species' characteristics of the vigna. The duration of the growing period of the samples of vigna is 58-90 days.

The average height of plants at the standard was 105 cm, for collection samples from 61 to 138 cm (VC=23,43%). The height of attachment of the lower the standard was 22 cm, for collection samples from 18 to 46 cm (VC=6,15%).

The number of beans per plant was 28 for standard, for collection samples from 9 to 33 beans (X_{av} = 22.12 pcs;

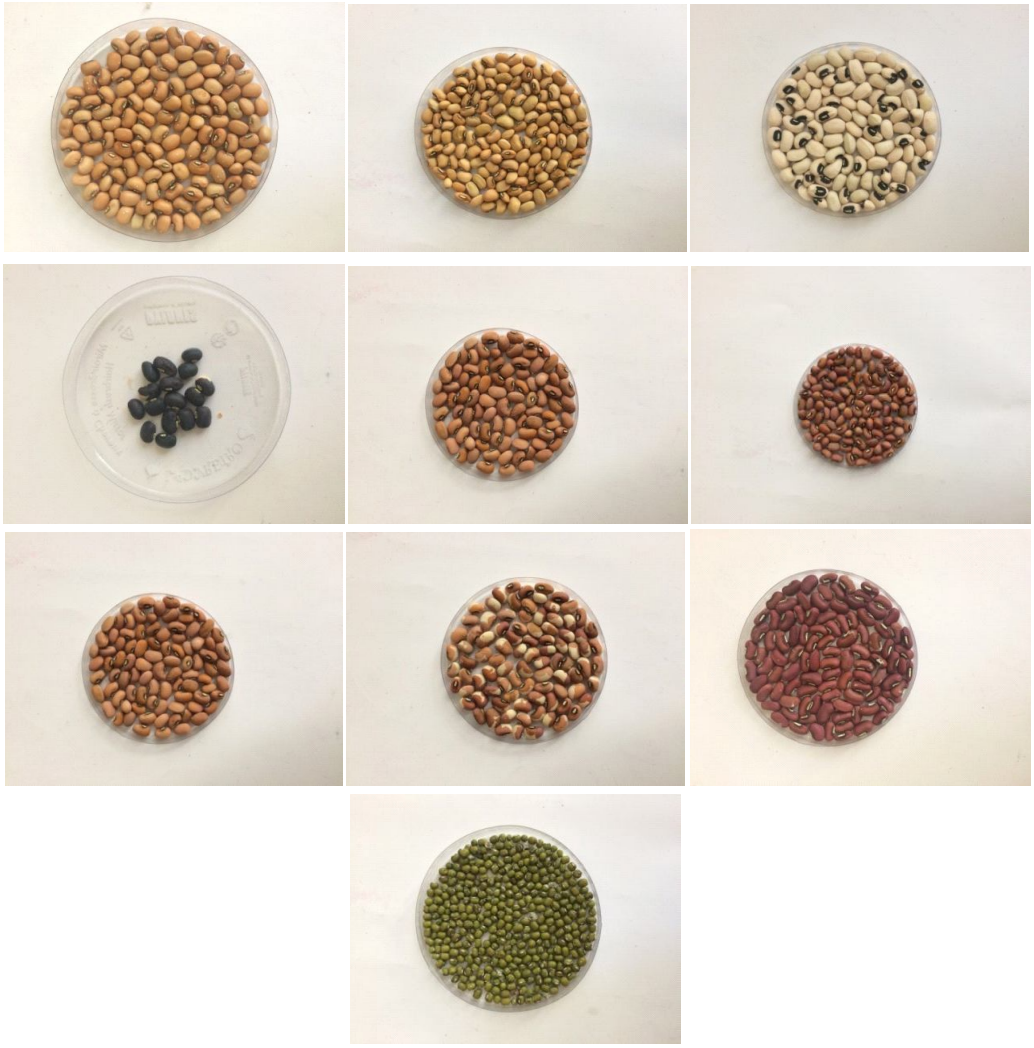


Fig 1: Variation in seed shape and color observed in cowpea collection.

VC= 42,96%). The largest number of beans per plant was formed by the following variety samples K-262 (23 pcs.), AzeVIG-2 (27 pcs), AzeVIG-3 (28 pcs.), AzeVIG-1 (33 pcs.); low number of beans was observed in variety samples K-429 (9 pcs.), K-269 (10 pcs.).

The number of seeds per plant was 136 for standard and 68 to 228 for collection samples (VC =5.67%) of seeds. The seed weight per plant is 22 g for a standard, 8 to 110 g for collection samples (VC = 25.43%). The mass of 1000 seeds for the standard was 163 g, for collection samples from 32 to 287 grams (VC = 37.78%). The mass of seeds from 1 m^2 for standard azeVIG-3 was 231.0 g. This indicator for collection samples varied from 90.0 g to 502.0 g (VC=30,06%).

By the mass of grain from 1 m^2 amples exceeding the standard were allocated: K-271 (270.0 g), azeVIG-2 (448.0 g), K-262 (488.0 g), AG-340 (502.0 g).

From the experience of breeding it found that one of the main conditions was the study by the breeder the correlation between the elements of fertility. Correlation coefficients are the most convenient indicator for studying the interdependence of quantitative traits. The results of the study of correlations are of interest when creating adaptive genotypes and obtaining the required performance characteristics.

The results of the correlation analysis revealed a correlation of genotypes of cow peafertility indicators:

- A direct high positive relationship is noted between the number of beans per plant and the number of seeds per plant (r=0.95**), between the number of beans per plant and the mass of seeds per plant (r = 0.93**); between the mass of seeds on the plant and the mass of 1000 seeds (r=0.92**);
- The average positive relationship is marked between the number of seeds per plant and the number of seeds per bean (r=0.58*);
- A direct positive relationship is noted between the mass of seeds per plant and the number of seeds per beans (r=0.46*); between the number of seeds per bean and yield (r=0.46*).

It is necessary to create new varieties, models of which combine, along with morphological features (compact bush, high attachment of the lower bean) and a set of economically useful traits. In order to more accurately compare the samples of productivity and suitability for mechanized harvesting of the samples of beans, they were divided into groups using cluster analysis (Stoilova *et al*., 2013).

To construct the dendrograms, the Euclidean distance and the method of unweighted pairwise grouping with averaging (UPGMA-unweighted pair group method using arithmetic averages) were used. According to the most important economically valuable attributes (plant height, height of attachment of the lower bean, number of beans and seeds per plant, seed weight per plant and 1000 seed weight, biological productivity), a statistical analysis was performed using the SPSS software package with further grouping.

In Fig 2 it can be seen that all the studied genotypes according to the aggregate morphological characters were classified into 3 main clusters. The resulting dendrogram made it possible to group genotypes depending on the level of seed productivity.

Cluster-I is characterized as medium-high and high-yielding samples. Samples K-261, K-262, K-264, K-273, K-268, K-271 are characterized as medium-growing and high-yielding.

Cluster-II includes 6 samples. Cluster-II combined high attachment of the lower bean. These samples were considered to be suitable for mechanical collection. The shape of the bush is compressed, determinative growth type. Samples K-1292, K-3480, K-5390 is characterized as a suitability for mechanical collection.

Cluster-III also includes 6 samples. These samples were tall, large-seed and high-yielding. Samples K-269, AG-340, azeVİG-2 are characterized as tall, close-seeded and high-yielding.

As a result of the study of varietal samples of cowpea, promising samples were identified, which can be successfully used as starting material for the selection of cowpea. When creating new varieties of cowpea as yields as starting material, more attention should be paid to plants belonging to the first and third clusters. The plants of these samples have a complex of positive economically valuable traits, the selection of which is most desirable for the selection of cowpea for high productivity.

When creating new varieties of cowpea as suitability for mechanized harvesting as a starting material, more attention should be paid to plants belonging to the first and second clusters. The plants of these samples have a set of positive economically valuable traits, the selection of which is most desirable for the selection of cowpea for high productivity and suitability for mechanized harvesting.

We need to discover correlational interconnectedness among features of cowpeas and on which features the selection should be carried out (Fig 3-5).

A regression analysis has been made among quantitative elements in order to identify features which have more influence on biological productivity. On the basis of the regression analysis, the linear relationship among studied quantitative elements of biological productivity is visualized in the Fig 2-4.

When creating new varieties of cowpea as suitability for mechanized harvesting as a starting material, more attention should be paid to plants belonging to the first and second clusters. The plants of these samples have a set of positive economically valuable traits, the selection of which is most desirable for the selection of cowpea for high productivity and suitability for mechanized harvesting.

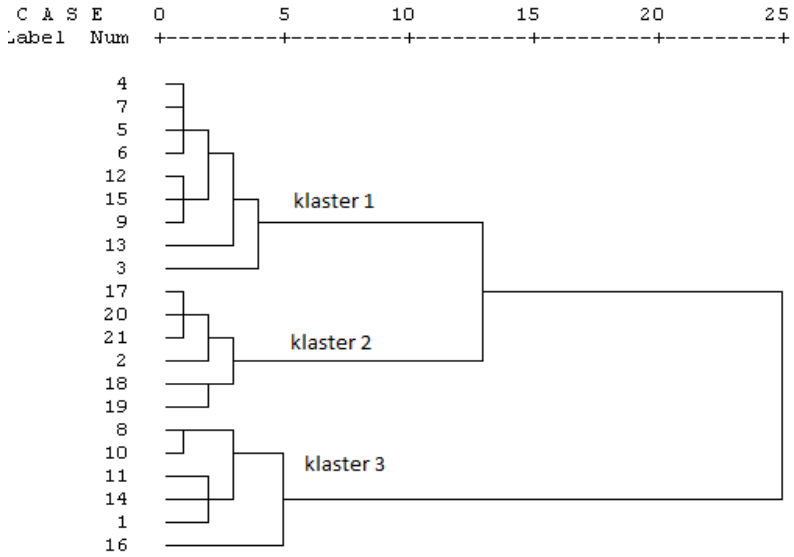


Fig 2: Dendrogram of clustering of cow pea samples on the elements of productivity and suitability for mechanical collection: Notes Cluster 1-4) K-262, 7) K-265, 5) K-264, 6) K-263, 12) K-271, 15) K-769, 9) K-268, 13) K-273, 3) K-261; Cluster 2-17) K-1138, 20) K-3480, 21) K-5390, 2) K-259, 18) K-1190, 19) K-1292; Cluster 3-8) K-267, 10) K-269, 11) AzeVIG-2, 14) AG-340, 1) K-257,16) AzeVIG-3.

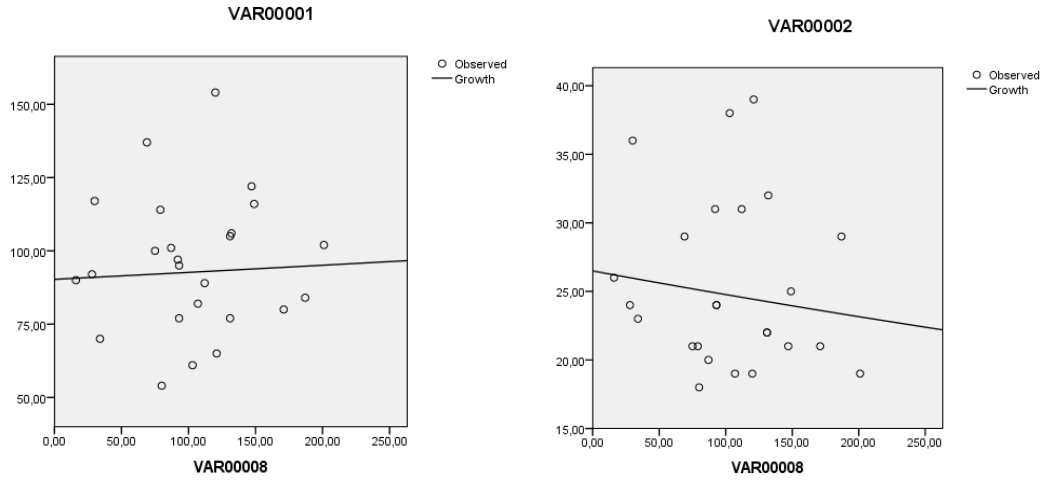


Fig 3: Relationships:- yield (VAR00008) of one plant with plant height (VAR00001); yield (VAR00008) with the height of attachment of the lower bean (VAR00002).

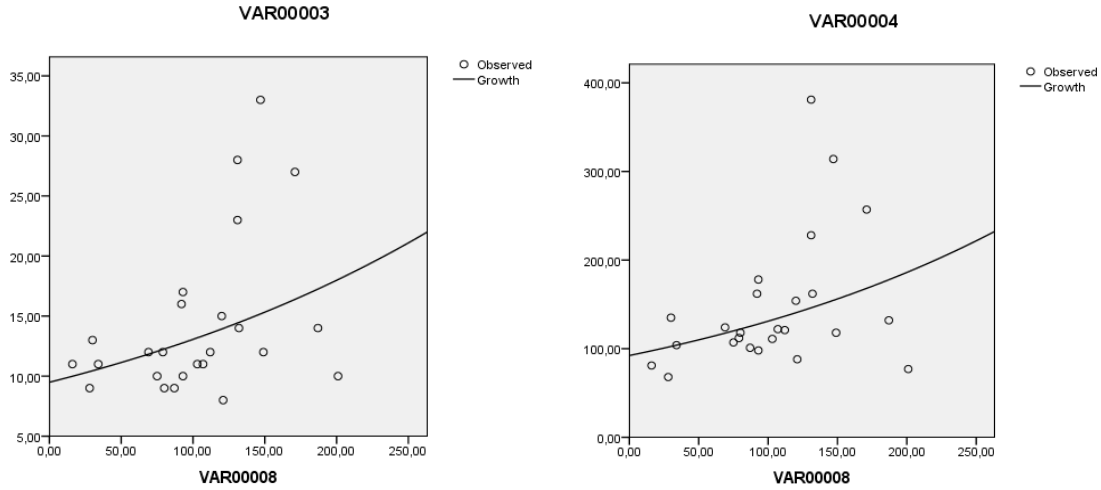


Fig 4: Relationships:- yield (VAR00008) of one plant with the number of beans per plant (VAR00003); yield (VAR00008) of one plant with the number of seeds per plant (VAR00004).

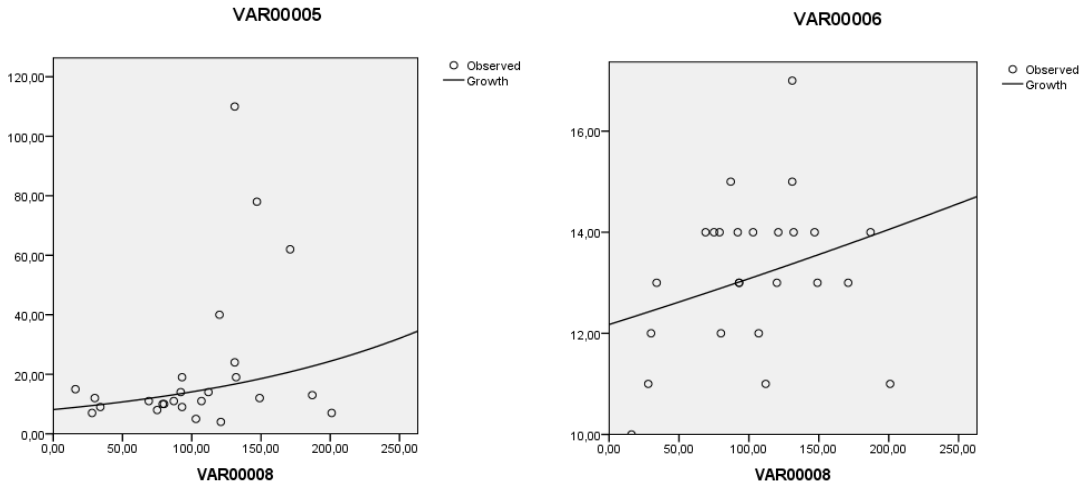


Fig 5: Relationships:- yield (VAR00008) of one plant with the mass of seeds per plant (VAR00005); yield (VAR00008) with a mass of 1000 seeds (VAR00006).

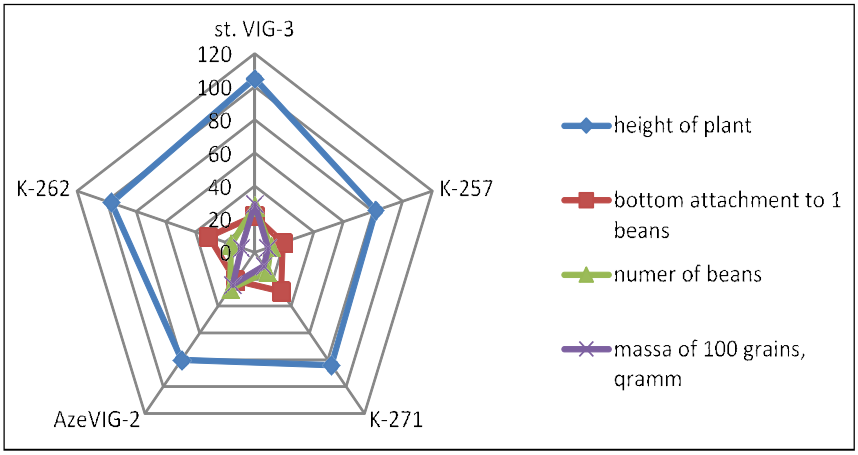


Fig 6: Characteristics of the samples selected as a source of high fertility among cowpea.



A. Variety Ayla forming beans. **B.** Variety Ayla started ripen.



C. Seed of Ayla variety.

Fig 7: Variety Ayla.

We proceeded to the evaluation of samples for quantitative and qualitative characteristics, identifying the relationship between their characteristics. As a result of studies, the most high-yielding and high-quality samples K-257, K-271, azeVIG-2, K-262 were found in the studied cowpea samples (Fig 6).

Studies have shown that to meet the demand for cowpea seeds, it is necessary to create new varieties, models of which combine, along with morphological features (compact bush, high attachment of the lower bean) and a complex of economically useful traits. According to the results of research, a diverse source material was obtained, as well as recombinants differing in early ripeness, stable seed yield with good commercial qualities.

The range of variation makes it possible to set the limits for the manifestation of cowpea in the conditions studied and the found correlation relationships between them show the grounds for selection.

We consider the creation of highly productive varieties in Azerbaijan with short and shortened interstices of the stem as one of the priority areas of selection. It is known that varieties with such characteristics provide a more ripening crop.

As a result of the research, a new variety of vigna Ayla (Pat. No. 00256, 2019) was created, which we obtained by repeated individual selection from the (VIR) collection. Ayla variety is characterized by early ripeness, the period from full germination to the start of technical ripeness 60-80 days. The mass of 1000 seeds is 110-118 g. The height of the plant is 70-80 cm and the attachment of the lower beans above the soil surface is 35-40 cm. The variety is high-yielding, resistant to diseases and growing conditions. The protein content in the seeds is 25.1% per cent. The average yield of the variety is 3.8-4.5 tons/per ha (Fig 7).

CONCLUSION

The results of the correlation analysis revealed a correlation between the genotypes of cowpea fertility indicators:

- A direct high positive relationship is noted between the number of beans per plant and the number of seeds per plant (r = 0.95**), between the number of beans per plant and the mass of seeds per plant (r = 0.93**); between the mass of seeds on the plant and the mass of 1000 seeds (r = 0.92**);
- The average positive relationship is marked between the number of seeds per plant and the number of seeds per bean (r = 0.58*);
- A direct positive relationship is noted between the mass of seeds per plant and the number of seeds per beans (r = 0.46*); between the number of seeds per bean and yield (r = 0.46*).

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